Methods for measuring ICT and innovation in the case of Republic Macedonia

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Abstract

This paper investigates the SII (Summary Innovation Index), GCI (Global Competitiveness Index), ICI (Innovation Capacity Index), GII (Global Innovation Index) and NRI (Networked Readiness Index) index as a tools about ICT and national innovation capacities in the case of the Republic of Macedonia and given countries. The concept of ICT and innovation and the methods for measuring it have been under constant dispute for decades. Without doubt, the measurement of ICT and innovation and theirs dynamics is of great importance for theoretical and empirical analysis of growth models, and to support the decision-making process of potential investors.

Composite indicators are widely used to compare a variety of countries with different backgrounds and levels of development, but these indicators do not tell us much about the country-specific ICT and innovation environment. At the same time, there is a separate branch of literature, which analyses ICT and national innovation systems, characterizing only a specific country and discussing factors that may impact ICT and innovation performance in the country in question. In this paper we try to bridge these two approaches. First, we conduct a comparative analysis of the ICT and innovation performance of the countries using composite indicators, and

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second, we analyze factors that may explain the differences in ICT and innovation performance between the countries.

Key words: ICT, innovation, Summary Innovation Index, Global Competitiveness Index, Innovation Capacity Index, Global Innovation Index, Networked Readiness Index;

1. Introduction

"*Never before in history has innovation offered promise of so much to so many in so short a time*".
Bill Gates
Founder of Microsoft Corporation

There are many indicators and ways of measuring ICT and innovation, but there are several problems in monitoring and measuring ICT and innovation. The first problem is the different understanding and definition of ICT and innovation, and the different target for monitoring, which has the consequence of having a number of different parameters and indicators. Standardized measurement and tracking of ICT and innovations allows annual or periodic ranking of countries and regions based on their innovative features.

Another problem concerns to the countries where the survey is conducted. The conventional wisdom is that ICT and innovation is most likely to drive growth in the highly developed countries, while poor and middle-income countries can import technology from abroad and therefore need not bother to innovate domestically. These suggestions are also in line with the recent study by the Economist, which showed that for high-income countries, innovation yields a smaller impact on economic growth than for low- and middle-income countries (Intelligence Unit, 2007). This finding also reflects the fact that for low- and middle-income countries, domestic innovation activity tends to facilitate the more efficient and rapid absorption of imported technology.

The evolution of national measurements has been presented by Milberg and Vonortas who have categorized them into four generations. The fourth generation of innovation metrics starts from 1950 up to today, in order to see how innovation in S&T (science and technology) developed and become more important and complex (Milbergs & Vonortas, 2004).

In the following section we present the methodological framework for analyzing ICT and national innovation performance. Also we present the results of the comparative analysis of ICT and innovation performance in the Republic of Macedonia between the indexes.

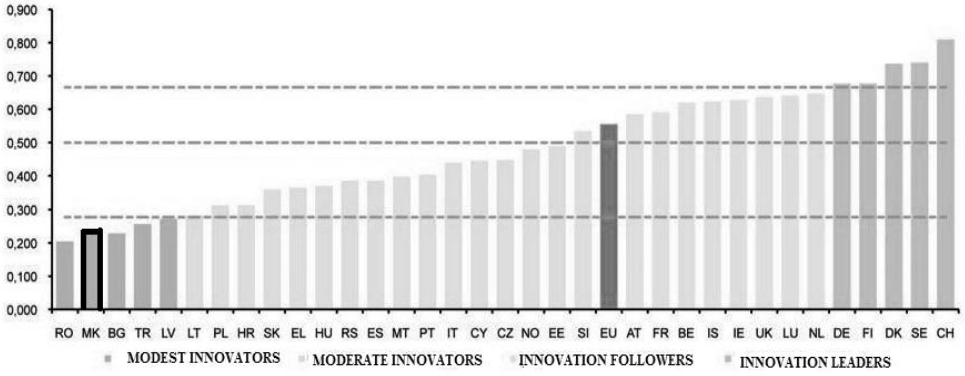
2. Assessment framework for national innovation performances

Each country's innovation performance is captured by a composite index measuring innovation performance, the SII (Summary Innovation Index). Based on the index value, countries can be classified in one of four performance groups: leaders, followers,

- moderate, and
- modest.

From analyzed 35 countries in 2015 year, Republic of Macedonia is on penultimate, 34 place. Republic of Macedonia belongs to the group modest innovators. In this group have 5 countries and Macedonia is on 4th places (Figure 1). Republic of Macedonia is only before Romania and compare to 2014 year, is down for 4 places.

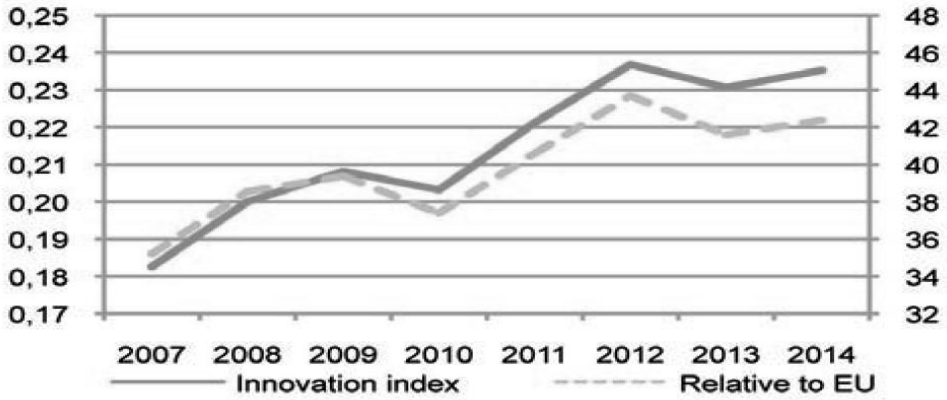
Figure 1: Innovation performances in Europe



Non-EU countries include Switzerland (CH), Iceland (IS), Norway (NO), Serbia (RS), Former Yugoslav Republic of Macedonia (MK) and Turkey (TR).
Source: European Commission, (2015), "*Innovation Union Scoreboard 2015*", Enterprise and Industry, Belgium, pg 31

Innovation performance was increasing between 2007 and 2012, but has declined slightly since then. Republic of Macedonia has been catching up to the performance level of the EU, its relative performance improved from 35% in 2007 to 42% in 2014 (European Commission, 2015) (Figure 2).

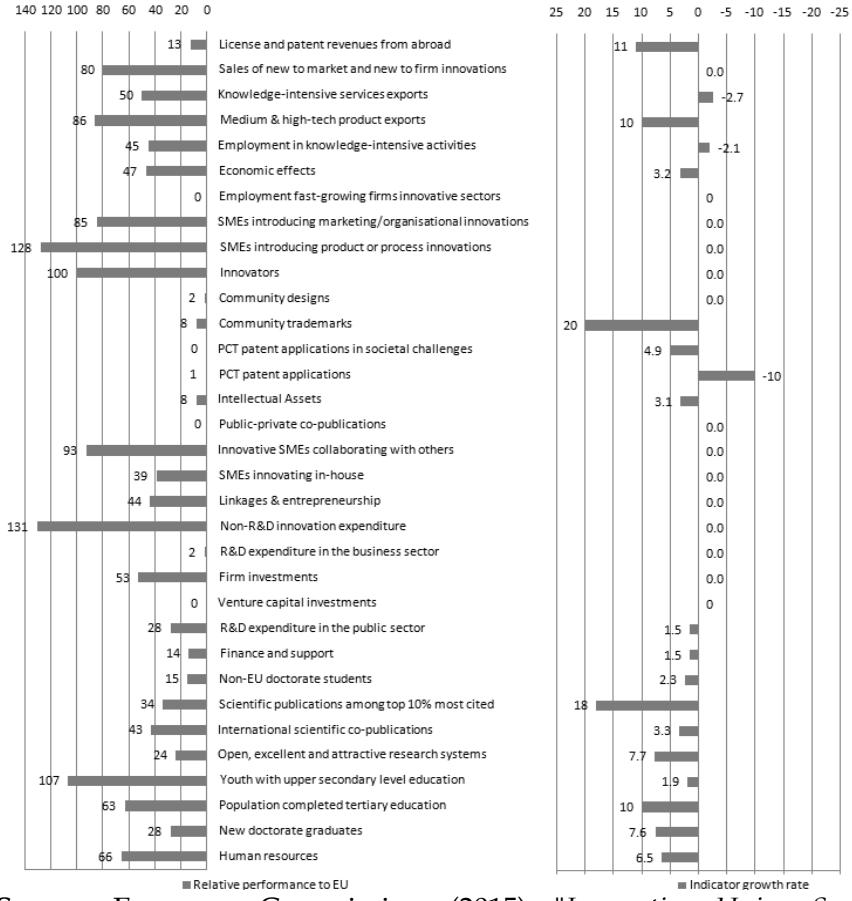
Figure 2: Macedonian's innovation performance and innovation index



Source: European Commission, (2015), "*Innovation Union Scoreboard 2015*", Enterprise and Industry, Belgium, pg 76

Republic of Macedonia trail quite a bit behind the neighbor countries. Compare with EU countries (0,555) is performing well below the average (0,235) for nearly all dimensions and indicators.

Figure 3: Performance relative to the EU where the EU = 100 and indicator growth rate of Republic of Macedonia



Source: European Commission, (2015), "*Innovation Union Scoreboard 2015*", Enterprise and Industry, Belgium, pg 76

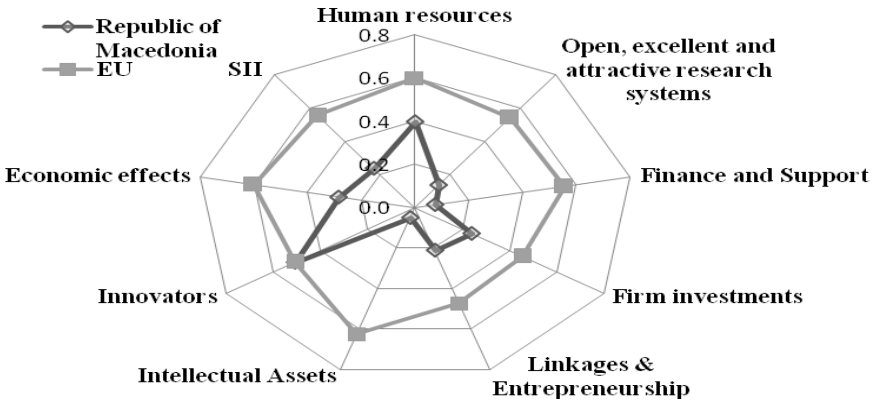
For many indicators performance has not changed over time as, due to a lack of data, data is available for one year only. In Republic of Macedonia performance has increased most significantly for the dimensions of human resources (6.5%) and open, excellent and attractive research systems (7.7%). At the indicator level, the highest growth can be observed for most cited publications (18%) and community trademarks (20%). PCT patent applications (-10%) can be observed for the only strong decline in

performance. However, these low scores in the Republic of Macedonia is the result of poor political and regulatory environment (Figure 3).

This results due to current political climate in Republic of Macedonia. That instability contribute to reduced export and import, difficult access to finance for investing and innovation, opaque governance of institutions that need to support all changes etc.

On Figure 4 are presented eight innovation dimensions and SII total value for the Republic of Macedonia and EU. Compare to EU, Macedonia is performing well in innovation dimension Innovators in indicators Non-R&D innovation expenditures and SMEs with product or process innovations, and its growth performance (3.7%) has introduced product or process innovators, but at the same time the lowest performance in Youth education and the Exports of medium and high-tech products.

Figure 4: Innovation performance per dimension of EU and Republic of Macedonia, 2015



Source: European Commission, (2015), "*Innovation Union Scoreboard 2015*", Enterprise and Industry, Belgium, pg 92-93 (composed by the author based on IUS 2015)

Table 1: Innovation performance of Republic Macedonia, EU and neighbor countries for 2015 year

	Republic of Macedonia	**EU 28**	**Bulgaria**	**Croatia**	**Romania**	**Slovenia**	**Serbia**
Human resources							
New doctorate graduates	0,5	1,8	1,0	2,3	1,8	1,9	0,8
Population completed tertiary education	23,1	36,9	29,4	25,9	22,8	40,1	24,7
Youth with upper secondary level education	86,4	81,0	86,0	95,0	79,7	91,5	83,4
Open, excellent and attractive research systems							
International scientific co-publications	157	363	226	453	188	1096	326
Scientific publications among top 10% most cited	3,8	11,0	3,3	3,2	3,5	6,9	N/A
Non-EU doctorate students	3,9	25,5	3,1	2,7	2,0	6,1	7,1
Finance and support							
R&D expenditure in the public sector	0,20	0,72	0,25	0,41	0,27	0,61	0,68
Venture capital investments	N/A	0,062	0,002	N/A	0,008	N/A	N/A
Firm investments							
R&D expenditure in the business sector	0,02	1,29	0,40	0,41	0,12	1,98	0,23
Non-R&D innovation expenditure	0,90	0,69	0,49	0,95	0,30	0,48	2,82
Linkages & entrepreneurship							
SMEs innovating in-house	11,3	28,7	11,6	19,3	10,6	25,8	25,2
Innovative SMEs collaborating with others	9,6	10,3	2,3	7,5	1,2	14,6	7,6
Public-private co-publications	N/A	50,3	4,3	30,0	6,6	80,6	8,4

Intellectual Assets							
PCT patent applications	0,05	3,78	0,50	0,57	0,20	2,79	N/A
PCT patent applications in societal challenges	0,00	0,98	0,11	0,22	0,05	0,90	N/A
Community trademarks	0,48	5,83	5,24	1,24	1,85	5,41	0,86
Community designs	0,03	1,13	1,20	0,15	0,19	1,82	0,01
Innovators							
SMEs introducing product or process innovations	39,2	30,6	13,6	21,6	5.2	32,6	28,6
SMEs introducing marketing/organisational innovations	30,8	36,2	17,6	30,4	18,1	35,9	40,6
Employment fast-growing firms innovative sectors	N/A	17,9	16,2	15,0	16,0	15,3	N/A
Economic effects							
Employment in knowledge-intensive activities	6,2	13,8	9,1	10,4	6,5	14,0	14,4
Medium & high-tech product exports	45,6	53,0	26,8	37,6	50,7	54,6	41,1
Knowledge-intensive services exports	24,6	49,5	28,6	17,6	49,2	25,7	47,7
Sales of new to market and new to firm innovations	9,9	12,4	4,2	10,0	3,7	10,5	12,4
License and patent revenues from abroad	0,09	0,65	0,05	0,04	0,06	0,12	0,09

Source: European Commission, (2015), "*Innovation Union Scoreboard 2015*", Enterprise and Industry, Belgium, pg 82

We analyze these innovation dimensions in more details to see the possible shortcomings of innovation measurement using the SII in Republic of Macedonia (Table 1).

1. The Enablers capture the main drivers of innovation performance external to the firm:

- Human resources – Indicators: New doctorate graduates and Population aged 30-34 with completed tertiary education, in Republic of Macedonia perform above the EU average and most of the neighbor countries average. In indicator Population aged 20-24 have completed at least upper secondary education, Republic of Macedonia average is higher than the EU average, but is lower than Croatia and Slovenia.
- Open, excellent and attractive research systems – indicator International scientific co-publications in Republic of Macedonia is remarkably lower than EU average and other neighbor countries, but in indicators most cited publications and Non-EU doctorate students is higher than neighbor countries average but is above EU average.
- Finance and support– in Republic of Macedonia indicators R&D expenditure in the public sector and Venture capital are lowest than neighbor countries and EU.
- Firm activities capture the innovation efforts at the level of the firm
- Firm investments – includes 2 indicators: R&D expenditure in the business sector (according to this indicator Republic of Macedonia perform above all neighbor countries and EU average) and Non-R&D innovation expenditure (only Croatia and Serbia have higher average than Republic of Macedonia)
- Linkages & entrepreneurship – includes 3 indicators: measuring innovation capabilities by looking at SMEs that innovate in-house (according to this indicator, Republic of Macedonia are behind the EU average, and compare to neighbor countries Republic of Macedonia is on the penultimate place and Romania is on the last place), Collaboration efforts between innovating firms (is smaller than EU average, but is before all neighbor countries except Slovenia). The indicator Research collaboration between the private and public sector is the weakest indicator in this innovation dimension.
- Intellectual assets – is the weakest group of indicators, where Republic of Macedonia is above EU and neighbor countries average.
- Outputs cover the effects of firms' innovation activities.
- Innovators – the number of firms that have introduced innovations onto the market and within their organizations. Innovators are comprised of SMEs introducing different types of innovation and

resource efficiency innovators. Republic of Macedonia has the most innovative SME's compare to EU average and neighbor countries. SMEs marketing and organizational innovations a fall behind EU average and Serbia and Slovenia.

- Economic effects – represent the factors that are external to the firms. In indicator Employment in knowledge-intensive activities Republic of Macedonia is behind EU and neighbor countries average, Republic of Macedonia is a little bit better than Bulgaria, Croatia and Serbia in indicator Medium & high-tech product exports. According to indicator Knowledge-intensive services exports Republic of Macedonia is on penultimate place and Croatia is on the last place, in indicator Sales of new to market and new to firm innovations also is behind EU and neighbor countries average (Republic of Macedonia has better performance than Bulgaria and Romania). We have bigger License and patent revenues from abroad than Bulgaria, Croatia and Romania, and with Serbia we have equal revenue.
- We can conclude that the SII in Republic of Macedonia declines most. One of the biggest problems is the low value of Intellectual Assets. There is still no strategy on intellectual property. The country should in particular: improve consultation of the stakeholders when drafting legislation; step up efforts to investigate and prosecute infringements of intellectual property; and reinforce capacity and coordination the authorities in charge of implementing the intellectual property laws and raise public awareness of the importance of protecting intellectual property rights.

3. Comparative analyze of different methods for measuring ICT and innovation

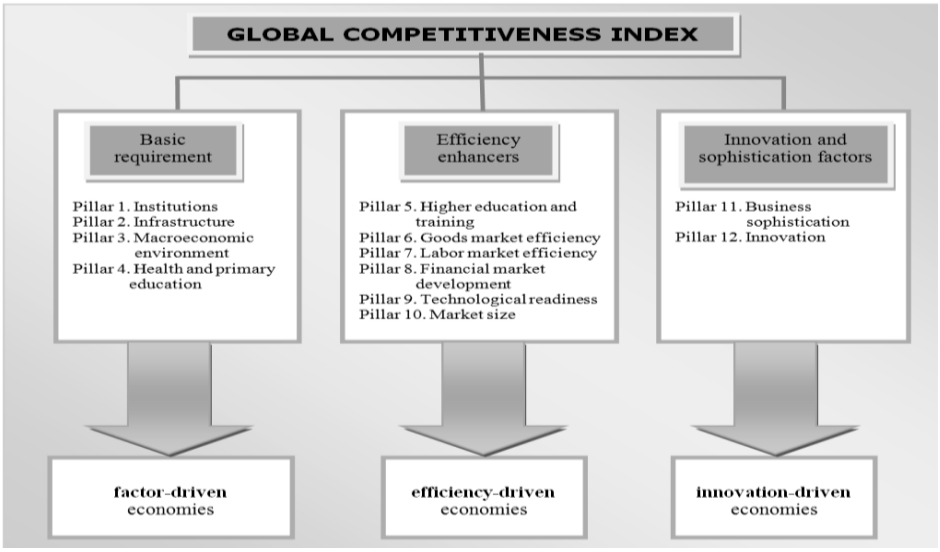
The Global Competitiveness Report was established by the World Economic Forum and has been identified by investors and creators of economic as reference studies in the field of international competitiveness. Also, these reports cover a large number of countries and provide a good picture regarding the position of the domestic economy, and comparison with other countries in the region and the world. This index tracks the various components that are grouped into 12 pillars including innovation (picture 1).

This report has been identified by investors and creators of economic as reference studies in the field of international competitiveness. Also, this report covers a large number of countries and provides a good picture regarding the position of the domestic economy, and comparison with other countries in the region and the world. For this paper and for the Republic of Macedonia is most important to analyze the last two pillars (11 and 12 pillar), Business sophistication and Innovation (Schwab, 2015).

The competitiveness analysis is bases through the GCI, which includes micro and macro-economic grounds of national competitiveness. GCI pillars are split in three main stages of development: basic requirements, efficiency enhancers, and innovation and sophistication factors.

They classify economies in three different stages of economic development: economies that rely on the factors of production, economies that rely on increasing efficiency and economies that rely on innovation.

Figure 5: The Global Competitiveness Index framework



Source: Schwab, K., (2015), "*The Global Competitiveness Report 2015-2016*", World Economic Forum, Geneva, pg 6

Since 2007 Republic of Macedonia is in the efficiency-driven stage of development. At this stage efficient goods and services, labor and financial markets are crucial, as well as knowledge acquired through higher education, specialized training and access to latest technologies. At this

point, competitiveness is increasingly driven by quality of products not by low prices.

As country move into the third stage, wages will have risen by so much that they are able to sustain those higher wages and the associated standard of living only if their businesses are able to compete using the most sophisticated production processes (11th pillar) and by innovating new ones (12th pillar).

11 pillar – Clusters are one of the key forms in establishing of economic stability and prosperity in a country, as in the strategy of competitive advantage the clusters increase productivity, the possibility of innovation and stimulate new business forms and expansion of the existing range of clusters. In this pillar Republic of Macedonia trend, high increase for 17 places according to last year (2014/2015). Eight of the nine indicators become greater: Nature of competitive advantage, Extent of marketing, State of cluster development, Production process sophistication, Local supplier quantity, Local supplier quality, Value chain breadth and Control of international distribution.

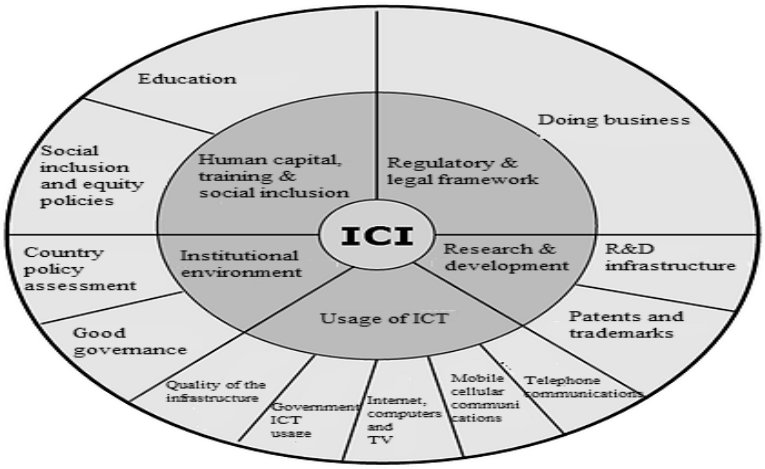
12 pillar – sufficient investment in R&D, especially by the private sector; the presence of high-quality scientific research institutions that can generate the basic knowledge needed to build the new technologies; extensive collaboration in research and technological developments between universities and industry; and the protection of intellectual property. Still poor indicators in this pillar are: Capacity for innovation, Availability of scientists and engineers, PCT patents, applications, Company spending on R&D and University-industry collaboration in R&D (Schwab, 2015).

Third year in a row, the Republic of Macedonia has seen improvement in all three groups. In the third stages of development, show the progress of 14 positions, because in the past three years, the government of the Republic of Macedonia adopted two packages of measures for improving the competitiveness. As a result of the measures from the first package adopted in March 2012, numerous improvements have emerged in the field of technological development, innovation, education and skills, infrastructure, health, agriculture and business conditions. The Government adopted the second package of measures in March 2015, which defines several strategic directions for developing the competitiveness of the private sector.

Another method for measuring innovation is ICI. ICI is a tool for assessing the extent to which countries have succeeded in developing a climate that will nourish the potential for innovation (Mouhallab and Jianguo, 2016).

Lopez-Claros & Mata has developed a methodological framework that allows, countries and organizations to follow their innovation progress. According to them ICI is built upon five pillars composed of a total of 61 variables (Picture 2). The ICI ranks countries according to their overall performance and also provides scores by pillars and subindexes which give a general idea of performance in those areas.

Figure 6: The Innovation Capacity Index framework



Source: Lopez-Claros, A., & Mata, Y, (2009), "*The Innovation Capacity Index: Factors, Policies, and Institutions Driving Country Innovation*". The Innovation for Development Report 2009-2010. Palgrave Macmillan, pg 20, available from: www.innovationfordevelopmentreport.org/Report2009/papers/101_LopezClaros_Mata.pdf (10.02.2013).

The ICI makes overwhelming use of hard data indicators. A full 90% of the variables used in the construction of the Index can be regarded as hard, that is, measuring directly some underlying factor (e.g., the budget deficit, research and development intensity, expenditure in education, etc.), and, therefore, not dependent on some survey instrument capturing, business or civil society perceptions. This is not to suggest that there is no place for

surveys in the construction of indexes. However, over the past decade or so, is considerable improvement in the ability of various international organizations to develop indicators for a large number of countries that capture factors that had previously not been easily measured. In the latest report on ICI 2011, Macedonia is ranked 42nd among 130 ranked countries (Lopez-Claros and Mata, 2010-2011). ICI is not published in the coming years, but it is particularly important to mention it, because of its significant contribution to measuring innovation.

4. Analyzing the ICT performances in the Republic of Macedonia

NRI measured the drivers of the ICT revolution globally, and have developed and evolved to reflect the growing importance of technology and innovation across the world. Macedonia is ranked 47th among 143 ranked countries in 2015, has improved his position by 10 places compared to 2014 (table 2).

Table 2: Macedonia NRI rank in last three years

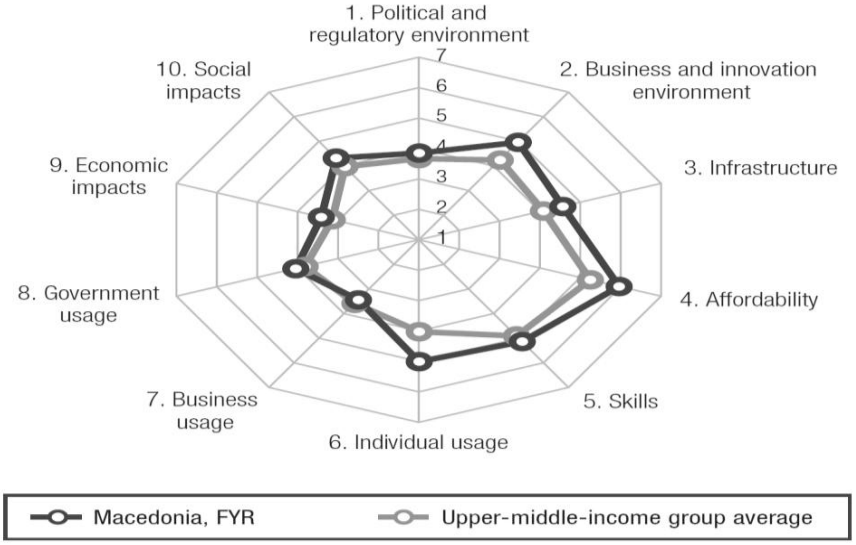
	Rank	Value
Networked Readiness Index 2015 (out of 143)	47	4.4
Networked Readiness Index 2014 (out of 148)	57	4.2
Networked Readiness Index 2013 (out of 144)	67	3.9

Source: Geiger, T., Dutta, S., Lanvin, B., (2015), "*The Global Information Technology Report 2015*", ICTs for Inclusive Growth, World Economic Forum, Geneva, pg 193, available at www.weforum.org/gitr. (02.06.2017)

According to the value of NRI, which is 4.4, Macedonia have better scores than other Balkan countries except Slovenia that ranks on 37th place.

It is important to determine the country's dependence on other countries according to the income group average. The Republic of Macedonia belongs to the group of countries with upper-middle-income group average. Upper-middle-income group is composed of a total of 37 countries, and the Republic of Macedonia moves within the limits of the average value of the countries that make up this group, and there are no major oscillations and deviations in none of the ten pillars (Figure 4).

Figure 7: Economy's score on each of the ten pillars



Source: Geiger, T., Dutta, S., Lanvin, B., (2015), "*The Global Information Technology Report 2015*", ICTs for Inclusive Growth, World Economic Forum, Geneva, pg 193, available at www.weforum.org/gitr. (02.06.2017)

The Table below shows values and rank of individual subindexes and pillars for Republic of Macedonia in 2015. On the ranking on the first subindex (Environment) greater negative influence has pillar Political and regulatory environment i.e. Efficiency of legal system in challenging regulations (92nd); Number of days to enforce a contract (89th) and Judicial independence (79th).

Table 3: NRI Economic Performance of the Republic Macedonia

	Rank (out of 143)	Value (1-7)[1]
A. Environment subindex	46	4.4
1. Political and regulatory environment	59	3.9
2. Business and innovation environment	39	4.8
B. Readiness subindex	46	5.3
3. Infrastructure	58	4.4
4. Affordability	29	6.1
5. Skills	64	5.2
C. Usage subindex	52	4.1
6. Individual usage	49	4.8
7. Business usage	85	3.5
8. Government usage	59	4.1
D. Impact subindex	55	3.9
9. Economic impacts	53	3.4
10. Social impacts	55	4.4

Source: Geiger, T., Dutta, S., Lanvin, B., (2015), "*The Global Information Technology Report 2015*", ICTs for Inclusive Growth, World Economic Forum, Geneva, pg 193, available at www.weforum.org/gitr. (02.06.2017)

According to rank of other subindexes, Impact subindex with his economic and social impact values, affects to achieve the total value of 4.4, and 47th place on the NRI list. This paper shows the rank of Macedonia compare to its neighbor countries that are part of EU and non-EU countries. The pillar Business usage has dropped significantly, followed by poor economic impact and the political and regulatory environment.

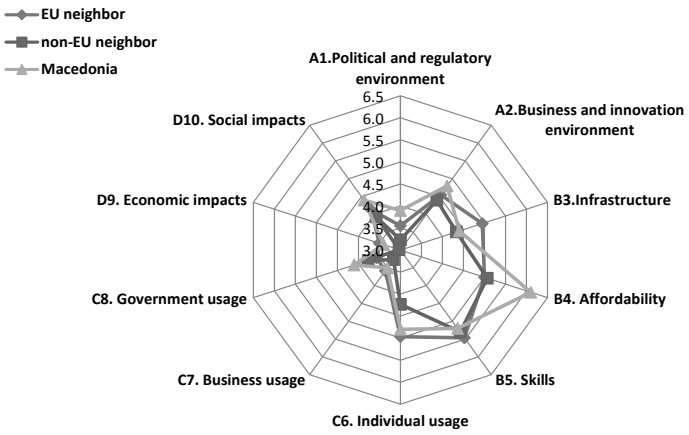
Macedonia is the best ranked among EU and non-EU neighbor countries in following pillars: Affordability, Government usage, Social impacts, Political and regulatory environment and Business and innovation environment. In affordability pillar Macedonia is ranked on 29th place and has improved its position by 59 places compared to 2014. The Affordability pillar assesses the affordability of ICTs in a country through measures of mobile telephony usage costs and broadband Internet subscription costs, as

[1]These indicators are always measured on a 1-to-7 scale (where 1 or 7 correspond to the worst or best possible outcome, respectively).

well as an indicator that assesses the state of liberalization, because more intense competition tends to reduce retail prices in the long run (Figure 5).

Developing countries fail to fully exploit the potential of technologies to drive economic and social changes, and reach developed countries. Based on this, it is noted that in one year the gap between countries with the best and worst performances has widened, i.e. those in the top ten have made twice stronger development of ICT services compared to the countries that are at the bottom of the list. According to the report, this shows the level of challenge that developing countries face it, if they want to develop the infrastructure, investments and skills needed for ICT. There are as many mobile subscriptions as human beings on the planet, but the ICT revolution will not be carried over voice and SMS but will require universal and high-speed Internet. Without cheap and high-speed Internet half of the world's population will continue to live in digital divide.

Figure 8: NRI score of EU and non-EU neighbor countries and Republic of Macedonia, 2015



Source: Geiger, T., Dutta, S., Lanvin, B., (2015), "*The Global Information Technology Report 2015*", ICTs for Inclusive Growth, World Economic Forum, Geneva, pg 118-263, available at www.weforum.org/gitr. (02.06.2017).

Macedonia is in the group of top ten most improved countries since 2012 until 2015. This is undeniable proof of how much Macedonia tend to create

an information-educated nation and use of ICT will improve and encourage the economy and create new jobs (Table 4).

Table 4: Ten most improved countries since 2012

Country	Rank (out of 142)	Value (1-7)	Rank (out of 143)	Value (1-7)	Score difference
Armenia	94	3,49	58	4,25	0,76
Georgia	88	3,60	60	4,23	0,63
United Arab Emirates	30	4,77	23	5,30	0,54
Kazakhstan	55	4,03	40	4,54	0,52
Russian Federation	56	4,02	41	4,53	0,51
El Salvador	103	3,38	80	3,89	0,51
Republic of Macedonia	66	3,91	47	4,42	0,51
Mauritius	53	4,06	45	4,49	0,42
Kyrgyz Republic	115	3,13	98	3,54	0,41
Latvia	41	4,35	33	4,75	0,40

Source: Geiger, T., Dutta, S., Lanvin, B., (2015), "*The Global Information Technology Report 2015*", ICTs for Inclusive Growth, World Economic Forum, Geneva, pg 15, available at www.weforum.org/gitr. (02.06.2017)

A number of activities have been undertaken in the Republic of Macedonia for promoting and widespread use of ICT, in the function of faster economic growth of the country through the approximation of ICT to citizens, organs of the state administration and the business community. This is achieved by adopting the National Strategy for the Development of Information Society, National Strategy for Development of Electronic Communications and Information Technologies and Program of the Ministry of Information Society.

Also National Council for Information Society was established, which includes representatives from the public, private, non-governmental sector, as well as representatives from universities participate. The main priorities are directed towards the development of e-education, e-citizens, e-business, e-infrastructure, e-government, and cyber security.

5. Measuring innovation in the Republic of Macedonia

The Global Innovation Index (GII) project was launched in 2007 with the simple goal of determining how to find approaches and metrics to better capture the richness of innovation in society and go beyond such traditional measures of innovation. The GII computation methodology takes into account several studies, such as the model of excellence of the European Foundation for Quality Management, as well as the Global Competitiveness Report issued by the World Economic Forum (Dutta, Lanvin and Wunsch-Vincent, 2015).

Table 5: GII – score of the given countries

Country	2007	2009	2010	2011		2012		2013		2014		2015		Income	Region
	Rank 1-107	Rank 1-130	Rank 1-132	Rank 1-125	Value	Rank 1-141	Value	Rank 1-142	Value	Rank 1-143	Value	Rank 1-141	Value		
America	1	1	11	7	56,57	10	57,7	5	60,3	6	60,1	5	60,1	high income	North America
Germanz	2	2	16	12	54,89	15	56,2	15	55,8	13	56,0	12	57,1	high income	Europa
United Kingdom	3	4	14	10	55,96	5	61,2	3	61,2	2	62,4	2	62	high income	Europa
Japan	4	9	13	20	50,32	25	51,7	22	52,2	21	52,4	19	54,0	high income	South East Asia and Oceania
France	5	19	22	22	49,25	24	51,8	20	52,8	22	52,2	21	53,6	high income	Europa
Sweden	12	3	2	2	62,12	2	64,8	2	61,4	3	62,3	3	62,4	high income	Europa
Singapore	7	5	7	3	59,64	3	63,5	8	59,4	7	59,2	7	59,4	high income	South East Asia and Oceania
Ireland	20	20	1	11	55,10	18	55,7	13	56,4	19	54,1	13	57,0	high income	Europa
Hong Kong	10	12	3	4	58,80	8	58,7	7	59,4	10	56,8	11	57,2	high income	South East Asia and Oceania
Swaziland	6	7	4	1	63,82	1	68,2	1	66,6	1	64,8	1	68,3	high income	Europa
Denmark	11	8	5	6	56,96	7	59,9	9	58,3	8	57,5	10	57,7	high income	Europa
Finland	13	13	6	5	57,50	4	61,8	6	59,5	4	60,7	6	60,0	high income	Europa
Netherlands	9	10	8	9	56,31	6	60,5	4	61,1	5	60,6	4	61,6	high income	Europa
Slovenia	43	36	26	30	45,07	26	49,9	30	47,3	28	47,2	28	48,5	high income	Europa
Hungary	36	47	36	25	48,12	31	46,5	31	46,9	35	44,6	35	43,0	high income	Europa
Croatia	55	62	45	44	37,98	42	40,7	37	41,9	42	40,7	40	41,7	high income	Europa
Bulgaria	81	69	49	42	38,42	43	40,7	41	41,3	44	40,7	39	42,2	upper-middle income	Europa
Montenegro	-	71	59	-		45	40,1	44	41,0	59	37,0	41	41,2	upper-middle income	Europa
Serbia	-	92	101	55	36,31	46	40	54	37,9	67	35,9	63	36,5	upper-middle income	Europa
Romania	62	69	52	50	36,83	52	37,8	48	40,3	55	38,1	54	38,2	upper-middle income	Europa
Macedonia	87	89	77	67	33,47	62	36,2	51	38,2	60	36,9	56	38	upper-middle income	Europa
Bosnia and Herzegovina	89	107	116	76	30,84	72	34,2	65	36,2	81	32,4	79	32,3	upper-middle income	Europa
Albania	100	121	81	80	30,45	90	30,4	93	30,9	94	30,5	87	30,7	upper-middle income	Europa

Source: Author own work, data from the *"The Global Innovation Index"* 2007 - 2015

The GII helps to create an environment in which innovation factors are under continual evaluation, and it provides a key tool and a rich database of detailed metrics for refining innovation policies. In the last year edition GII model includes 141 countries/economies that represent 95.1% of the world's population and 98.6% of the world's GDP (in current US dollars).

The GII relies on two sub-indices: the Innovation Input Sub-Index and the Innovation Output Sub-Index each built around pillars. The first Sub-Index of GII is the Innovation Input Sub-Index. It's the simple average of the first five pillar scores. Five input pillars capture elements of the national economy that enable innovative activities: Institutions, Human capital and research, Infrastructure, Market sophistication, and Business sophistication. Enabler pillars define aspects of the environment conducive to innovation within an economy. Innovation outputs are the results of innovative activities within the economy. Output Sub-Index is calculated as the simple average of the last two pillars. Although the Output Sub-Index includes only two pillars, it has the same weight in calculating the overall GII scores as the Input Sub-Index. There are two output pillars: Knowledge and technology outputs and Creative outputs.

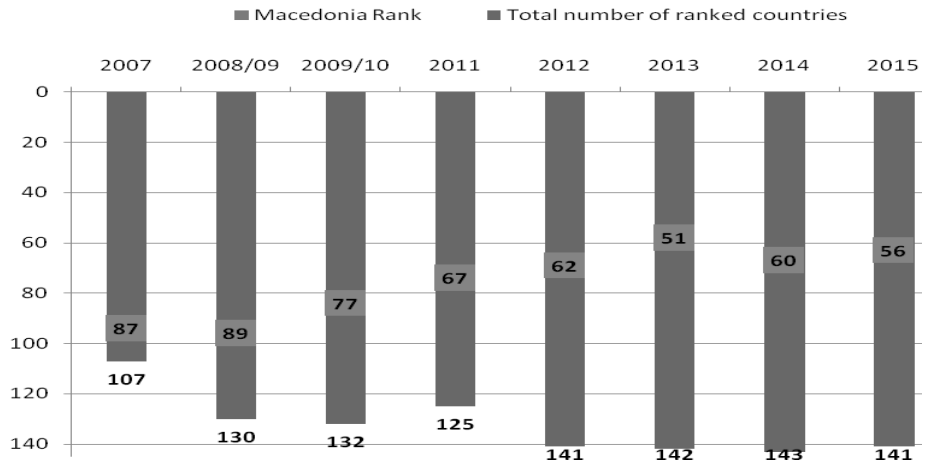
The overall GII score is the simple average of the Input and Output Sub-Indices. The Innovation Efficiency Ratio is the ratio of the Output Sub-Index to the Input Sub-Index. It shows how much innovation output a given country is getting for its inputs. Each pillar is divided into three sub-pillars, each of which is composed of individual indicators, for a total of 79 indicators. The GII pays special attention to presenting a scoreboard for each economy that includes strengths and weaknesses, making accessible the data series, and providing data sources and definitions and detailed technical notes.

Macedonia is ranked 56th (up from 60th in 2014), 12nd among upper-middle-income countries, and 33rd in the region (Figure 6). This year Macedonia is one of the countries in the region that increased in the rankings. With a population of 2.1 million and a GDP per capita of PPP$11,395.3 (PPP$10,904.5 in 2014), Macedonia ranks 55th in the Output Sub-Index, 56th in the Input Sub-Index, and 64th in the efficiency ratio; it also shows relative strengths in Institution (55th), Market sophistication (46th) and Creative outputs (46th). Relative weakness shows in Human capital & research (55th), Infrastructure (94th), Business sophistication (62nd) and Knowledge & technology outputs (69th) (Figure 7).

Macedonia has relative strong position performance in few indicators: easy of starting a business (3th), ease of paying taxes (7th), Ease of resolving insolvency (33rd), easy of protecting investors (21st), ISO 14001 environmental certificates (20th), Microfinance gross loans (17th), ISO 9001 quality certificates (25th), Communications, computer and information services exports (28th), Number of national feature films produced/per million population 15–69 years old (22nd) and Printing & publishing output manufactures (16th).

Macedonia has weakness in the QS University ranking average score of top 3 universities (73rd), Gross expenditure on R&D, % GDP (85th), Government's online service (113th), E-participation (119th), Logistics performance (108th), Market capitalization, % GDP (99th), total value of stocks traded, % GDP (84th), GERD performed by business, % of GDP (75th), Patent families 3+ offices/ per billion PPP$ GDP (108th), and Citable documents H index (98th).

Figure 9: Macedonia rank in GII

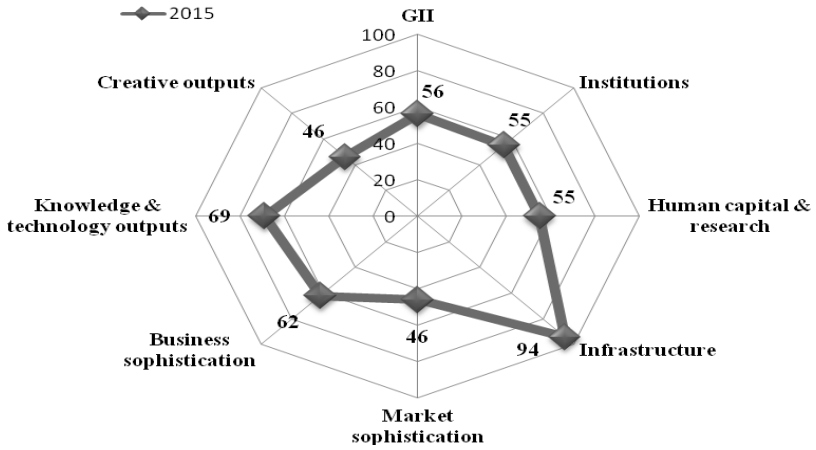


Source: Author own work, data from the "*The Global Innovation Index*" 2007 - 2015

In the report we can see that top five countries are Swaziland, followed by United Kingdom, Sweden, Netherland and finally America. The first three places are the same like last year, only Netherland improved its position by 1 place compared to 2014 and America is again in the first five countries, at the expense of that Finland is on the 6th place (Table 5).

Compare to neighbor countries Macedonia is still behind Slovenia, Hungary, Bulgaria, Croatia, Montenegro and Romania, and it's better than Serbia, Bosnia and Herzegovina and Albania (Table 5).

Figure 10: Macedonia rank in GII for 2015



Source: Dutta, S., Lanvin, B., and Wunsch-Vincent, S., (2015), "*The Global Innovation Index 2015: Effective Innovation Policies for Development* "Cornell University, INSEAD, and WIPO, pg 285

The paper aims to contribute to a better understanding of the complexity of composite indicators and to an improvement in the techniques currently used to build them. Such composite indicators provide simple comparisons of countries that can be used to illustrate complex and sometimes elusive issues in wide-ranging fields, e.g., environment, economy, society or technological development.

Based on this we can conclude that Macedonia has good performance in this index, has stability and continuously growth. The euro zone debt crisis and the global economic crisis caused a significant slowdown in Macedonia, but in 2013, as the global economy recovered, Macedonia increased. Although the global economic crisis has undoubtedly played a role in limiting funds available for ICT investment, innovation and infrastructure. According to this report, innovation is considered to be one of the main pillars of economic development. One way of analyze would be through ICT innovation. The best method of doing this is through analyzing country development.

All above presented approaches for measuring innovation and ICT are constructed with different indicators and measuring methodology. However, innovation and ICTs are part of them. Indexes enable country rankings, and compare the country capacity with other countries in the world or region.

The various indices that measure the innovation potential and capacity of countries are: SII (out of 35 in 2015), ICI (out of 130 in 2011), GII (out of 141 in 2015), GCI (out of 140 in 2015-2016) and NRI (out of 143 in 2015). In Table 6 we have the ranking of the Republic of Macedonia in the previously mentioned indices. It should be noted that if we observe only the rank of a country, one can notice that the country is experiencing a growth in the rank due to the fall of the ranks of other countries, but the index score of the country should also be taken into consideration.

Table 6: Rank of the Republic Macedonia for different indexes

	Republic Macedonia
Index	Rank
GII	56
ICI	42
SII	32
GCI	60
NRI	47

Source: Author own calculation using the data from different reports

6. Conclusion

Republic of Macedonia is liberalized and opened up to foreign investment; telecommunications achieved a high degree of business internationalization. The large number and high value of greenfield projects in telecommunications over the last two decades testifies of the quantity and value of investment dedicated to creating new productive assets.

Republic of Macedonia have proactively engage in international cooperation on energy policy, including technology and innovation, with a view to leverage the full potential from public energy R&D investment, notably in smart mobility and energy efficiency. Proactively engage in

international co-operation on energy policy, including innovation and technology, with a view to leverage the full potential from public energy R&D investment, notably in smart mobility and energy efficiency. Develop an integrated energy and climate strategy based on supply scenarios and robust demand; a shared vision for the development of the energy system and new technology needs; and actions to be taken towards regional integration to reinforce the country's energy security. Macedonia has to made eco-innovation and clean energy technologies priorities for research and development and make a resource efficient energy supply. Macedonia is experiencing constrains in relation to technology, science and innovation policies, similar to those of other neighbor countries since gaining independence.

The aim of this paper is not to give definite answers, but to touch upon certain anomalies of the Macedonian ICT and innovation system thru SII, GCI, ICI, GII and NRI. The scope of innovation changes from region to region but influence of ICT is everywhere evident. Today innovation in the ICT industry is most revolutionary.

We do believe that Macedonia has a lot to learn with respect to building sustainable innovation system and ICT, from the developed countries. However, imitating other countries' "triumphant" systems in this respect would be a short sighted solution from a public policy perspective. The Macedonian ICT and innovation system has specificities on its own and these should be taken into account when analyze Macedonian infrastructure. Hence we have to devise a system on our own. In doing so we should rely upon the successful models developed by others, but not blindly.

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